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LAB 28.1 INVESTIGATION

Use with Section 28.1

Your Age and Weight on Other Planets

What could be more down-to-earth than a person's age and weight? Yet both are controlled by astronomical forces. The Sun swings Earth around once, and we say that another year has gone by. But how many birthdays would you have had if you had been living on Mercury? The pull between Earth and a human body leads us to declare that a person weighs some amount. How heavy would you be if you lived on Venus? You can use Kepler's third law and Newton's law of universal gravitation to answer these questions.

PREPARATION

PROBLEM

What would your age and weight be if you lived on another planet?

OBJECTIVES

- **Calculate** your age on the other eight planets of the solar system.
- **Calculate** your weight on each planet.

MATERIALS

calculator
scale

PROCEDURE

1. Kepler's third law states that the orbital radius (a) of a solar system planet relates to its orbital period (P) in this formula if P and a are expressed in solar system units: $P^2 = a^3$. In solar system units, the unit of time is the year, the unit of length is the astronomical unit (AU), and the unit of mass is the mass of the Sun. Use this relation and the data in Table 1 to find out the length of the planet's year in Earth years.
2. You now have the number of Earth years per planet year, but what you want is the number of planet years per Earth year. So calculate the reciprocal.
3. Multiply the number of planet years per Earth year by your age to obtain your age on the planet. Record your results, to three decimal places, in Table 2.

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PROCEDURE, *continued*

4. To calculate your weight on another planet, use Newton's law of universal gravitation.

$$F = G\frac{m_1 m_2}{r^2}$$

F is the force between two bodies, which in this case is your weight on the planet; G is the universal constant of gravitation; m_1 is the mass of the planet; m_2 is your own mass; and r is the distance between the centers of the two bodies, which in this case is the radius of the planet. Notice that even though your weight is different from planet to planet, your mass remains the same.

5. Using the scale, weigh yourself to find your weight in pounds. Convert your weight from pounds (lb) to kilograms (kg). Use the following formula to make your calculations. 1 lb = .455 kg

6. Using Table 1, and Newton's law of universal gravitation in step 4, calculate your weight on each planet. m_1 is your mass, which you calculated in step 5. m_2 is the mass of the planet. $G = 6.6726 \times 10^{-11}$ $m^3/kg \cdot s^2$.

7. Record your results in Table 2.

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DATA AND OBSERVATIONS

Table 1

Planet	Orbital Radius, *a* (AU)	Planetary Radius, *r* (km)	Planetary Mass, *m* (10^{24} kg)
Mercury	0.387	2439.7	0.3302
Venus	0.723	6051.8	4.8685
Earth	1.0	6378.1	5.9736
Mars	1.524	3397	0.64185
Jupiter	5.204	71 492	1898.6
Saturn	9.582	60 268	568.46
Uranus	19.201	25 559	86.832
Neptune	30.047	24 764	102.43
Pluto	39.236	1195	0.0125

Table 2

Planet	Your Age in Planet Years	Planet Mass/ Earth Mass (kg)	Earth Radius/ Planet Radius (km)	Square of Radius Ratio (km)	Your Weight on Planet (N)
Mercury					
Venus					
Earth					
Mars					
Jupiter					
Saturn					
Uranus					
Neptune					
Pluto					